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Application No.	S2002/0223
Date of Filing	27th March 2002
Applicant	Commergy Technologies Limited, an Irish Company of 133 Lansdowne Park, Ballsbridge, Dublin 4, Ireland

Dated this 14TH day of April 2003.

PRIORITY DOCUMENT
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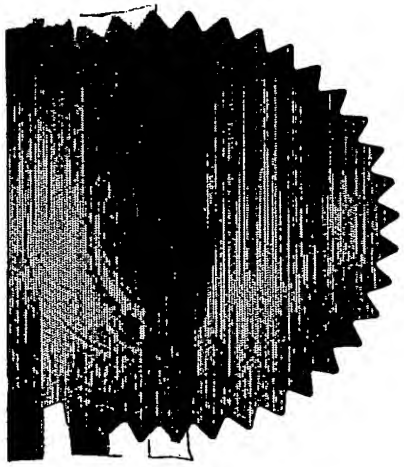

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APPLICATION No. S020223

FORM NO. 1

REQUEST FOR THE GRANT OF A PATENT

PATENTS ACT 1992

The Applicant(s) named herein hereby request(s)
[ ] the grant of a patent under Part II of the Act
[X] the grant of a short-term patent under Part III of the Act
on the basis of the information furnished hereunder.

1. Applicant(s)

COMMERGY TECHNOLOGIES LIMITED
133 Lansdowne Park
Ballsbridge
Dublin 4
Ireland.
an Irish company

2. Title of Invention
A magnetic structure

3. Declaration of Priority on basis of previously filed application(s) for same invention (Sections 25 & 26)

Previous Filing Date	Country in or for which filed	Filing No.

4. Identification of Inventor(s)

Name(s) and addresse(s) of person(s) believed by the Applicant(s) to be the inventor(s)
George Young,
an Irish Citizen of 11 Woodlands Park, Blackrock, County Dublin, Ireland.

5. Statement of right to be granted a patent (Section 17(2) (b))

The Applicant derives the right to apply by virtue of a Deed of Assignment dated March 26, 2002

6. Items accompanying this Request

(i)	[X]	prescribed filing fee (Euro 60.00)
(ii)	[ ]	specification containing a description and claims
	[X]	specification containing a description only
	[X]	Drawings referred to in description or claims
(iii)	[ ]	An abstract
(iv)	[ ]	Copy of previous application(s) whose priority is claimed
(v)	[ ]	Translation of previous application whose priority is claimed
(vi)	[X]	Authorisation of Agent (this may be given at 8 below if this Request is signed by the Applicant(s))

7. Divisional Application(s)
The following information is applicable to the present application which is made under Section 24 -

Earlier Application No.
Filing Date:

8. Agent

The following is authorised to act as agent in all proceedings connected with the obtaining of a patent to which this request relates and in relation to any patent granted -

Name & Address

Cruickshank & Co. at their address recorded for the time being in the Register of Patent Agents is hereby appointed Agents and address for service, presently 1 Holles Street, Dublin 2.

9. Address for service (if different from that at 8)

Signed Cruickshank & Co.

By:- Michael Lucas Executive.

Agents for the Applicant

Date March 27, 2002.

"A Magnetic Structure "

Introduction.

The present invention relates to a printed circuit board assembly and method of manufacturing such an assembly and in particular to a method of manufacturing a dual magnetic structure for use in power converters.

In certain types of power converters there is usually a requirement for a dual magnetic structure, for example twin inductors which share a common flux path. In many applications of this type the two inductors work with inductors whose associated flux levels will largely cancel in a central leg. This allows the central leg to be smaller and have lower losses than otherwise would be the case.

Dual magnetic structures of this type may be implemented in single printed board structures. A difficulty with this implementation is that the "open" nature of any air gap implies either excessive electrical magnetic interference generation or excessively costly containment measures. The large distance between input and output terminals of the inductor also implies a large loop area, which can cause radiating noise. Further, this adds considerably to the printed circuit board area, which is wasteful of area resources.

Further, in electronic power converter design low output noise and ripple is an important requirement. It is known to use capacitors to reduce the noise level, however, to date the design has been very much restricted by the fact that capacitors with minimal lead length and low effective loop area must be employed.

To achieve a low output ripple in power converters it is necessary to use an output inductor with a small value. In practice, a high value of current slope can reduce turn-on loss and can alleviate reverse recovery effects. This implies a high value of ripple current. Therefore, to achieve a low output ripple it can present problems to a designer. The problem is addressed by having a multi-stage filter. Initially, one can use ceramic capacitors, which can handle high ripple current with minimal loss and then some small value inductance can be added to achieve a reduction in ripples.

The inductance values required are typically small. For example, 400H_z an inductance of 10$_n$4 will have impedance of 25 mΩ material in the context of capacitor impedance of approximately15 mΩ. However, this design adds complexity to the power converter.

It will be appreciated that in this specification the term "printed circuit board" is to be afforded a loose interpretation in that it is intended to encompass main sections and sub-sections of board such that a metal stamping could be considered to function as a printed circuit board section.

The present invention is directed towards a solution for the above-mentioned problems by providing a dual magnetic structure and integrated post-filter inductor incorporating the dual magnetic structure and method for producing such structures.

Statements of Invention.

According to the present invention there is provided a method of manufacturing a dual magnetic structure comprising the steps of:

mounting at least two conducting elements to a main printed circuit board;

providing a metal stamping in the form of a printed circuit board section on the main printed circuit board in close contact with at least one conducting element.

The advantage of manufacturing the dual magnetic structure in this way is that electrical magnetic interference (EMI) is reduced. Ideally, the conducting elements are inductors. Further, it is possible to manufacture the inductors so that the input and output terminals of the inductors are positioned close together allowing for close placement of a capacitor with low loop area and consequently low electrical magnetic interference.

Further, the method comprises the additional step of providing a ferrite leg with air gaps and ferrite covers. This allows for a closed magnetic path resulting in smaller

stray flux and reduced interference in the structure.

Ideally, the metal stamping is in the shape of an "S". It will be appreciated more than one printed circuited board section can be incorporated into the dual magnetic structure depending on the application.

In another embodiment of the present invention there is provided a method of manufacturing a power converter having a dual magnetic structure comprising the steps of:

mounting at least two conducting elements on a main printed circuit board;

providing a metal stamping in the form of a printed circuit board section on the main printed circuit board in close contact with at least one conducting element;

extending the length of the metal stamping to reduce noise in the power converter.

By extending the length of the metal stamping on the printed circuit board allows extra track capacity to be used thus reducing losses in the power converter.

In a further embodiment of the present invention there is provided a method of manufacturing a power converter having a dual magnetic structure comprising the steps of:

mounting at least two conducting elements on the main printed circuit board;

providing a metal stamping in the form of a printed circuit board section on the main printed circuit board in close contact with at least one conducting element;

mounting an additional inductor to reduce ripple current in the converter.

Detailed Description of the Invention.

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a plan view and sectional view of the dual magnetic structure of the invention.

Fig. 2 is another embodiment of the present invention incorporating additional tracking.

Fig. 3 illustrates the dual magnetic structure with an additional post-filter inductor.

Referring now to Fig. 1 there is illustrated a plan view and sectional view of the present invention indicated generally by the reference number 1. Inductors 2, 3 are implemented as two windings on either side of a central ferrite plate 4 with appropriate ferrite covers 6, 7 having air gaps 8. One advantage of this structure is that the input and output terminals of the inductors 2, 3, which are not shown, can be positioned close together allowing for close placement of a capacitor with low loop area and consequently low EMI, again not shown. The magnetic path is also closed resulting in a smaller stray flux, which can cause interference problems.

When the structure is being manufactured a lower winding, inductors 2, 3 are formed using a planar or quasi planar structure. Frequently a single turn winding can be employed in these cases. A planar printed circuit board section 5, 9 can be affixed to the main printed circuit board by pins or by solder paste reflow techniques. A single turn section can be implemented by reflowing a solid piece of stamped metal 5, typically pre-tinned copper onto the main printed circuit board using solder paste techniques. This can be implemented as part of the initial first side reflow process, where the sub-board section 5, 9 or copper section can be machine placed for this

process, with appropriate contact points and support tabs provided on the main printed circuit board (not shown).

The second-side reflow can then be performed by using placing a ferrite section 4 in which is fixed the sub-board or copper piece 5, 9 appropriate for the second side. This assembly may also be machine-placed as required.

The magnetics assembly may then be completed by affixing ferrite plates 6, 7 top and bottom.

Referring now to Fig. 2 there is provided a dual magnetic structure for use with power converters illustrated by the reference numeral 20 in which the stamping 5 has been extended as shown. The use of sub-boards and/or stamping (5, 9) are extended to provide low-resistance interconnects to for example an output pin.

This has particular relevance in the case of DC-DC converters having terminals 21, 22 using a format known as the "half-brick". This has an output pin spacing of 1.4" (35mm). In order to achieve low noise performance it is necessary to route the output tracking or stamping 5 close to the pin of opposite polarity so that capacitors 23, 24 with minimal lead lengths and low effective loop area can be employed. This implies a need to have a long length of tracking back to the pin of opposite polarity. Using S-type pieces of copper or printed circuit sub-boards (5, 9) allows extra track capacity to be used for this length of tracking, thus reducing losses.

Referring now to Fig. 3 there is illustrated a dual magnetic structure incorporating a filter inductor to reduce the ripple current in power converters indicated generally by reference numeral 30. As already mentioned in the prior art it is know to provide inductance values of 10 mH. The present invention provides a simple implementation of this inductor by the use of the "S" pieces of the tracking 5 by extending the piece of metal or tracking to allow an effective and low cost implementation of an inductor of this value. The plates can be cantilevered over the output metal work or board sections in the space around the metal pieces can be filled with a magnetic material as illustrated in Fig.3. The printed circuit board may provide the required air gap or a piece of low permeability magnetic material may be used in this context.

To achieve a value of 10nH requires dimensions calculated as follows:

1- $\Phi = LI$. With I of typically 60A, and L of 10nH, then Φ is 0.6u Wb.

2- $H = I/l$ where L is the path length. If this is a 2mm printed circuit board thickness, then H is 30KA/m

3- $B = u_0 H$, or $B = 4\pi\ 10^{-7}\ H$ or $12\ \pi\ 10^{-3}$

4- $\Phi = BA$. Thus A is $0.6\ 10^{-6} / 12\ \pi\ 10^{-3}$ or $60\ 10^{-6}\ m^2$

It will be appreciated that while dual magnetic structures and integrated post-filter inductor applications are disclosed for converters, the invention can be incorporated into other applications such as that for micro-electronics and integrated circuit design.

In the specification the terms "comprise, comprises, comprised and comprising" or any variation thereof and the terms "include, includes, included and including" or any variation thereof are considered to be totally interchangeable and they should all be afforded the widest possible interpretation. The term theoretical refers to the scientific community and not the inventor.

The invention is not limited to the embodiments hereinbefore described but may be varied in both construction and detail.

PS0203.Mar.13

Cruickshank & Co.

ABSTRACT

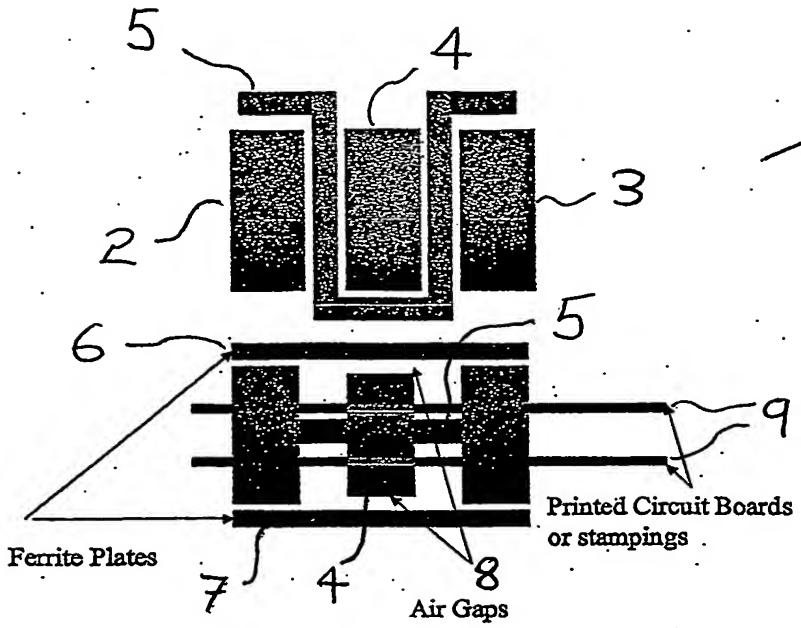

Fig 1

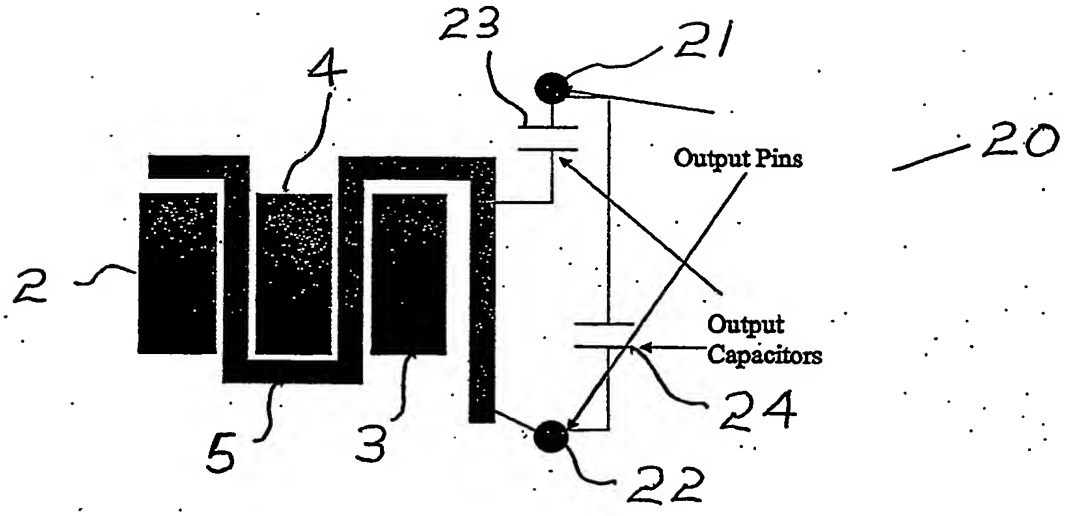

Fig 2

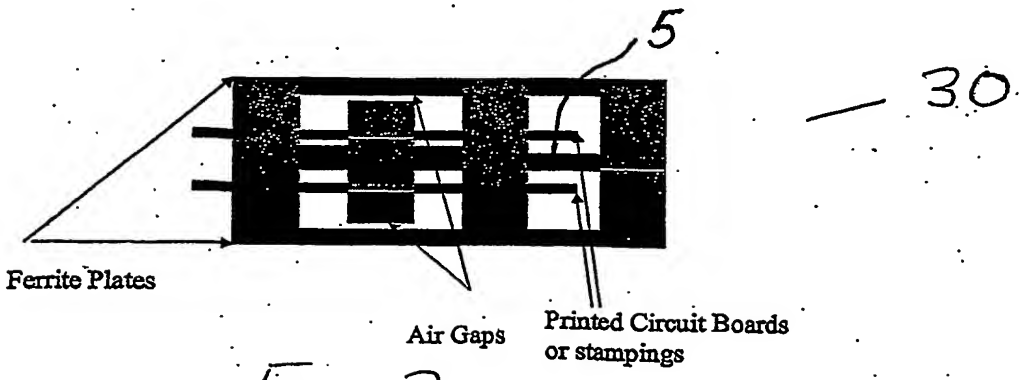

Fig 3